

## Sulfur-induced polioencephalomalacia in a herd of rotationally grazed beef cattle

## Debra Haydock

**Abstract** — Central nervous system disease occurred in a herd of rotationally grazed beef cattle consuming water containing 3400 ppm sulfate. Clinical signs, pathologic findings, and high water sulfate levels confirmed the diagnosis of sulfur-induced polioencephalomalacia. The incidence of disease reduced when the herd was switched to a low sulfate water source.

**Résumé** — Polioencéphalomalacie reliée au soufre dans un troupeau de bœufs de boucherie gardé sur pâturage en rotation. Une atteinte du système nerveux central s'est produite dans un troupeau de bœufs de boucherie gardé sur pâturage en rotation et consommant de l'eau contenant 3400 ppm de sulfates. Des signes cliniques, des trouvailles pathologiques et des taux de sulfates élevés ont confirmé le diagnostic de poliencéphalomalacie causée par le soufre. L'incidence de la maladie a été réduite lorsque le troupeau a eu accès à une eau à faible teneur en sulfates.

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n early September 2001, a herd of 220 rotationally grazed crossbred beef cattle on pasture in central Saskatchewan experienced neurological illness and sudden death losses. The cattle had been moved several times over the summer and had been grazing 20 acres of green oats and wheat for several days before illness set in. They were previously on an area of pasture with a hauled-in water supply. The water source for this sector of pasture was a low dugout that the cattle had already been drinking from earlier in the season. The first indication of disease was the acute death of a mature cow. Examination of the herd at this time showed that the majority of the mature females were sluggish and lethargic. The calves appeared unaffected. The next day, 2 more cows were discovered in sternal recumbency. They were unresponsive to external stimuli, lacked menace reflexes, and had slowed palpebral reflexes. They had mild tremors of the head and neck and were slobbering profusely. These cows were treated with thiamine (Thiamine HCl; Vétoquinol, Lavaltrie, Quebec), 0.5 mL/kg bodyweight (BW), IM, once, and placed under observation. Another cow died suddenly on the 3rd day of the outbreak, and the 2 sick cows, which did not respond to treatment, were euthanized. All 4 cows

Western College of Veterinary Medicine, University of Saskatchewan, 52 Campus Drive, Saskatoon, Saskatchewan S7N 5B4.

Dr. Haydock's current address is Assiniboia Veterinary Clinic, Box 1386, Assiniboia, Saskatchewan S0H 0B0.

Address all correspondence and reprint requests to Dr. Haydock.

Dr. Haydock will receive 50 free reprints of her article, courtesy of *The Canadian Veterinary Journal*.

were submitted to the Prairie Diagnostic Services in Saskatoon, Saskatchewan, for necropsy. Water samples from the dugout were submitted to test for sulfate levels.

Visual observation of the herd revealed many lethargic and obtunded mature females. Clinical examination of the 2 sick females revealed tremors of the head and neck, and profuse slobbering. There were no menace reflexes and the palpebral reflexes were slowed. The cows were in sternal recumbency and unresponsive to stimuli. They displayed normal rumen motility, and the temperature and pulse were within normal limits.

The history and neurological clinical signs indicated that the lesions in these cows were in the cerebral cortex and brain stem; they were highly suggestive of polioencephalomalacia (PEM). Differential diagnoses included sulfur-induced PEM, thiamine deficiency-induced PEM, lead toxicity, water-deprivation sodium ion toxicity, hypovitaminosis A, and *Hemophilus* meningoencephalitis (1,2,4,8,9).

Water samples were collected to test for high sulfate levels. The cows were treated with thiamine and monitored for a response that would correlate with thiamine deficiency. Blood samples to measure thiamine levels were not taken, out of consideration for expense to the client. Lead toxicity was not likely as the cows still had good rumen motility and were not exhibiting hyperexcitability. Blood lead levels were not tested, because of the expense. Water deprivation was not consistent with the history; therefore, brain sodium levels were not tested. The clinical signs were not consistent with hypovitaminosis A in that the pupils were not fixed and dilated, and there was an absence of convulsions. *Hemophilus* meningoencephalitis was ruled out because the cows did not exhibit fever, enlarged joints, dyspnea, or harsh lung

sounds. The cows showed no real improvement upon treatment with thiamine and the owner opted for euthanasia. Euthanasia was by lethal injection to ensure that the brain remained intact for postmortem examination.

Gross postmortem findings revealed that all 4 cows were in good body condition. Each individual exhibited a massive round focal area of hemorrhage in the brain stem, measuring 2 to 2.5 cm in diameter.

Histopathologic examination revealed mild to moderate to extensive multifocal cortical gliosis. Sections of cortex revealed groups of necrotic neurons with reaction in the surrounding brain tissue. There was moderate to massive hemorrhage present in the area of the brain stem. The microscopic findings differed in intensity between animals but presented a consistent pattern of lesions.

The clinical presentation combined with the gross and histopathological lesions supported the diagnosis of PEM. The dugout water sample contained 3400 ppm sulfate. This level is consistent with causing sulfur-induced PEM (1–3,8,9).

In cases of PEM caused by thiamine deficiency, treatment with thiamine may bring about alleviation of clinical signs within hours of administration (2). The lack of response by the cows that were treated helped to rule out thiamine deficiency as a differential diagnosis in this case, and the owner elected to euthanize the 2 cows the day after treatment.

The final diagnosis in this outbreak was sulfur-induced PEM. The cow herd was supplied with low-sulfate hauled water from an off-farm source. There were no more clinically ill animals or death losses, and the herd returned to a normal activity level.

High sulfate levels in the diets of ruminants are an increasingly common component of cases of PEM (1–3,6,8,9). Excess sulfates can be present in both the feed and water (7). Hot weather is a common trigger of sulfate-induced PEM, as daily water consumption increases and cattle ingest more than the maximum safe level of sulfur (9).

The National Research Council (NRC) states the daily sulfur requirements in feed to be 1500 ppm for mature beef cattle. The maximum tolerated dose is 4000 ppm (10).

The National Research Council guidelines indicate that a 533 kg crossbred cow consuming 11.14 kg of feed daily (approximately 2% body weight) would have a maximum tolerated daily dose of 44.6 g of sulfur (10).

With an environmental temperature of 21.2°C, a mature lactating beef cow will consume 64 L of water per day (10). Consumption of 64 L of water containing 3400 ppm sulfates results in a daily ingestion of 74 g of sulfur. This level exceeds the maximum daily intake of sulfur by 1.66 times without accounting for sulfur from the feed, which was not measured in this case.

Polioencephalomalacia caused by lead toxicity and water deprivation are clinically and histologically indistinguishable from that caused by excess dietary sulfur (1,2,4,5,8,9). Differentiation must be by tissue lead and sodium ion concentrations. Whole blood and liver can be submitted to check for lead levels. Elevated brain sodium levels and a supportive history of water deprivation will rule-in sodium ion toxicity.

Gross postmortem examination may reveal brain lesions that fluoresce under ultraviolet light at 366 nm (1). The brain may be swollen and soft with flattened gyri. Vascular necrosis and hemorrhage may be seen in acute cases of PEM (1,3,9).

On microscopic examination, neurons are shrunken and necrotic. The nuclei are small and faded or absent, and the neuropil becomes homogeneous in appearance. Macrophages may be present in increased numbers, and cavitations and dead space form as necrotic nuclei are cleared away (1).

This report demonstrates that water-derived sulfur sources are an important component of the diet of ruminants. Yearly water evaluation of all sources a cattle herd may drink from can be a crucial monitor of herd health.

The number of cases of sulfur-induced PEM has increased dramatically in the past few years (8,9). This may be due to a decreased tolerance by cattle to excess dietary sulfur as surmised by one author (11). Perhaps more importantly, recent drought situations in Saskatchewan and Alberta have led to depletion of water supplies and have exponentially increased the risk of herd outbreaks of PEM.

Education of beef producers about the effects of high sulfate feeds and water has become increasingly important. Current herd health programs that focus on preventive medicine should include routine testing of water supplies and feed sources.

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